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Cigarette Ignition Propensity of Upholstered Furniture

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EXECUTIVE SUMMARY

CPSC staff conducted two studies intended to provide information on the cigarette ignition resistance of new upholstered household furniture. One study involved cigarette ignition testing of upholstered furniture; the other was based on a survey of manufacturers to determine the types of materials used in the manufacture of furniture. Both studies looked at production by firms that participate and those that do not participate in the Upholstered Furniture Action Council's (UFAC) voluntary program to reduce the likelihood that furniture will ignite from cigarettes.

Based on the findings of these studies:

- a substantial majority (an estimated 83 percent) of upholstered furniture would not result in sustained ignition from carelessly dropped cigarettes;

- an estimated 92 percent of cigarettes placed on key locations would not be expected to result in sustained ignitions;

- ignition of furniture from lit cigarettes is primarily determined by upholstery cover fabrics: all chairs with predominantly thermoplastic cover fabrics resisted ignition in CPSC tests; ignition resistance generally decreased with greater cellulosic content; fabric weight (for cellulosic fabrics) may also play a role -- heavier cellulosic fabrics generally tend to be more likely to ignite; other factors that are not well-understood also might affect the ignition propensity of fabrics;

- overall, about 90 percent of upholstered furniture may be in conformance with the UFAC Program (including production by non-UFAC firms that technically is not certified).

- some chairs that passed all UFAC component tests ignited in full scale tests, and others that did not meet all of the UFAC criteria resisted ignition in full scale tests; fabric and filling material selection is more predictive of ignition resistance than conformance with all aspects of the UFAC program.

INTRODUCTION

In 1993 the National Association of State Fire Marshals petitioned the Consumer Product Safety Commission (CPSC) to initiate a proceeding to regulate upholstered furniture flammability. The Commission voted to defer a decision on the part of the petition dealing with cigarette ignition, pending an evaluation the effectiveness of the Upholstered Furniture Action Council's (UFAC) Voluntary Action Program in addressing cigarette ignition hazards. UFAC was formed by major furniture industry associations in 1974. The Voluntary Action Program was developed in the late 1970's, and amended (as "Phase 2") in 1983. The program requires classification of upholstery fabrics into either "Class I" or "Class II," based on a performance test. All conforming furniture must comply with specified construction criteria for welt cords, decking substrates, filling materials, and interior fabrics; and Class II fabrics (which are generally more prone to ignite from cigarettes) used with polyurethane foam seat cushions must have a barrier material that passes a barrier performance test between the fabric and foam. Materials are certified as meeting UFAC tests by the suppliers. This report presents the staff's assessment of industry conformance with the UFAC Program.

In addition to assessing conformance with the voluntary program, the staff was directed to evaluate the cigarette ignition hazard associated with furniture currently being made. In response, Commission staff developed a test program to determine the resistance of currently manufactured residential furniture to ignition from cigarettes. Forty chairs manufactured by UFAC members and 18 chairs manufactured by firms not participating in the UFAC Program were tested by the Directorate for Laboratory Sciences. A report on the cigarette ignition testing by the Directorate for Laboratory Sciences is attached as Appendix A.[1]

The agency also contracted with Abt Associates to conduct a survey of upholstered furniture manufacturers in 1995. The mail survey sought information on upholstery fabrics, filling materials, and other components of upholstered furniture that could affect ignition from a burning cigarette. A report by the Directorate for Economic Analysis on the findings of this and previous surveys of manufacturers is attached as

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[1] "Upholstered Furniture Flammability Testing: Cigarette Ignition Data Analysis," Gail Stafford and Linda Fansler, Directorate for Laboratory Sciences, Division of Engineering Laboratory, U.S. Consumer Product Safety Commission, July 17, 1996.

Appendix B.[2] This report combines the findings of the ignition testing and the survey of manufacturers to estimate the likelihood that current furniture production will ignite (or resist ignition) from burning cigarettes.

SUMMARY OF FULL SCALE CHAIR TEST RESULTS

The full scale test results are most indicative of the likelihood that furniture would ignite from cigarettes. LSEL staff tested the 58 chairs using modified procedures specified in the Draft Proposed Standard for the Flammability (Cigarette Ignition Resistance) of Upholstered Furniture (1981). These procedures call for unfiltered cigarettes (covered by 5-inch squares of sheeting fabric) to be placed at locations on a chair where a carelessly dropped cigarette might land. Three cigarettes were generally tested at the front welt edges, the seat cushion surface, and at the crevices formed by the seat cushion, side, back, and pillow. Test cigarettes were judged to have resulted in sustained ignitions if chars extended more than 3 inches from the cigarettes, or if obvious ignition occurred. Details of the testing procedures may be found on pages 3-5 of Appendix A. Table 1 summarizes the results of the full scale tests of the 58 chairs by participation in the UFAC Program.

Table 1. Chair Test Results, by Participation in the UFAC Program

Affiliation	Chairs Tested	1 or More Ignitions		Cigarettes Tested	Number of Ignitions	
	Number	No.	%	Number	No.	%
UFAC	40	12	30%	455	67	15%
NONUFAC	18	7	39%	195	32	16%
COMBINED	58	19	33%	650	99	15%

The data presented in Table 1 show that the test chairs from UFAC participants were somewhat more likely to be resistant to ignition than those from firms not participating in the program. However, the percentage of test cigarettes leading to sustained ignitions was virtually the same for both groups of manufacturers.

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[2] "Results of Surveys of Manufacturers of Upholstered Furniture," Charles Smith, Directorate for Economic Analysis, CPSC, September 1996.

Table 2 presents the results of full scale testing by fiber content of upholstery fabrics. The findings are consistent with previous full-scale testing by the CPSC and California's Bureau of Home Furnishings, in that cellulosic fabrics (*e.g.*, those made from cotton and rayon fibers) were shown to be more likely to ignite from cigarettes than thermoplastic fabrics (*e.g.*, those made from polyester, nylon, and polyolefin fibers). For the furniture covered with blend fabrics, ignition propensity was generally greater for fabrics with higher cellulosic content; none of the furniture covered with fabrics having blends of at least 50 percent thermoplastic fiber ignited.[3]

Table 2. Chair Test Results, by Fiber Content of Fabrics

Fabric Fiber Content	Chairs Tested	1 or More Ignitions		Cigarettes Tested	Number of Ignitions	
	Number	No.	%	Number	No.	%
Cellulosic	18	14	78%	204	80	39%
Thermoplastic	10	0	0%	105	0	0%
Blends	28	4	14%	329	16	5%
All Fabrics*	58	19	33%	650	99	15%

* Results for "All Fabrics" include one chair covered with silk fabric (3 of 3 test cigarettes led to ignitions) and one leather covered chair (no ignitions).

Among the other findings of the full scale tests conducted by LSEL, 53 of 58 upholstery fabrics (91 percent) were UFAC Class I. The five UFAC Class II fabrics were 100 percent cellulosic. Although they had barriers as required by the UFAC Program, all five had sustained ignitions of test cigarettes in full scale testing. Other findings from the chair tests are detailed in Appendix A.

[3] based on test chairs fabric fiber content information provided by manufacturers and LSEL laboratory analysis of fiber content.

CONFORMANCE WITH THE UFAC VOLUNTARY ACTION PROGRAM

The UFAC Program is designed to prevent the use of furniture components that may be more likely to lead to cigarette ignition of assembled furniture. The UFAC Program is not designed to predict the ignition performance of all UFAC furniture. A substantial majority of the chairs included in LSEL's recent study were made of component materials that conformed to the UFAC guidelines. Ninety-three percent of the 40 chairs manufactured by UFAC members met the required UFAC Test Methods. Seventy-two percent of the 18 chairs manufactured by non-UFAC furniture manufacturers conformed to the UFAC guidelines. Overall, 86 percent of the 58 chairs, both UFAC and non-UFAC, conformed to requirements of UFAC Test Methods. If weighted by market shares (UFAC firms account for about 90 percent of total shipments) overall estimated conformance would be about 90 percent.

A report on the results of a 1994 survey of upholstered furniture manufacturers by Heiden Associates (under contract to UFAC) estimated that 85 to 88 percent of the total value of shipments of wood frame upholstered furniture in 1993 complied with the UFAC program. Adding sleep furniture to upholstered wood furniture brought estimated compliance up to 86 to 89 percent of the dollar value of shipments of these two major categories of upholstered furniture.[4] The UFAC establishments surveyed by Heiden Associates reported that 98 percent of the value of their production of upholstered wood furniture was in conformance with the UFAC Program. Heiden Associates assumed that the UFAC establishments that did not respond had 75 to 90 percent of their total value of shipments in conformance with the voluntary program. Heiden Associates assumed none of the production by non-UFAC establishments conformed to the UFAC Program. The findings of the Heiden Associates study are consistent the staff's overall estimate of 90 percent conformance with the UFAC Program (including production by non-UFAC firms that technically is not certified).

The full scale test results for chairs that conformed with the UFAC Program and chairs that did not conform to the UFAC Program found conforming chairs that ignited and nonconforming chairs that resisted ignition (see Appendix A for details). These findings illustrate that cigarette-ignition resistance of upholstered furniture is more dependent on the fabrics and filling materials used, rather than conformance with all aspects of the UFAC Program.

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[4] Heiden Associates, Inc., Report on Survey of UFAC Members re: Compliance with Upholstered Furniture Cigarette Ignition Flammability Standard, December 15, 1994.

SUMMARY OF SURVEYS OF MANUFACTURERS ON FABRICS AND MATERIALS USED TO MAKE UPHOLSTERED FURNITURE

Compared to information on fabrics and filling materials used by UFAC participants in previous surveys, the 1995 survey shows increased use of materials with generally greater resistance to ignition from cigarettes: non-cellulosic fabrics and polyester fiberfill filling materials. There has been a continuing trend towards greater use of polyester fiberfill (shown to be among the more cigarette ignition-resistant filling materials) in contact with fabrics in seats, backs, and inside arms of upholstered furniture, at the expense of urethane foam and other filling materials.

The trend away from welt cord use in seat cushions observed in prior surveys has continued. Interior fabrics were used in about one-third of seat, back, and loose arm cushions (and somewhat less in other areas). Nearly all of the welt cords and interior fabrics used by UFAC participants were said to be in conformance with the Program's applicable component tests. With the presumed exception of items such as reclining chairs and convertible sofas, nearly all upholstered furniture was made with dust covers; woven or nonwoven thermoplastic fabrics were most commonly used for this purpose.

Fabrics and filling materials used by the sample of non-UFAC establishments generally were not significantly different from those used by the UFAC establishments. Compared to the previous survey of non-UFAC establishments, greater use of a generally more cigarette ignition-resistant filling material, polyester fiberfill, was found.

The findings from the 1995 survey, and comparisons to previous surveys of fabric and filling material use, are presented in Appendix B.

COMPARISONS OF FABRICS AND FILLING MATERIALS USED: CHAIR TESTS AND SURVEY OF MANUFACTURERS DATA

The chairs tested by the Engineering Laboratory were intended to be representative of the types of products in the market, especially regarding fabric selection. The testing results by characteristics were then planned to be weighted according to the findings of the survey of manufacturers. As shown in Table 2, 18 of 58 test chairs (31 percent) were covered with cellulosic fabrics. Of the 40 UFAC chairs, 12 were cellulosic (30 percent). UFAC participants surveyed in 1995 were

asked to estimate the percentage of their total fabric yardage that was *predominantly* cellulosic.[5] The mean response of manufacturers (weighted by value of shipments) was that 31 percent of fabric yardage was predominantly cellulosic. Non-UFAC establishments were not statistically different in their use of predominantly cellulosic fabrics. Since the survey estimate includes fabrics made with other fibers (*e.g.*, thermoplastics) blended with cellulosic fibers, it appears that the furniture industry makes less use of 100 percent cellulosic fabrics and blended fabrics that are mostly cellulosic than the sample of test chairs.

Regarding filling materials of test chairs, it appears that the seat cushioning, back, and side filling materials were quite close to the findings of the 1995 survey of UFAC participants. Both samples found that more than three-fourths of chairs had seat cushions with polyester fiberfill over foam cushions.

Of the 40 UFAC chairs tested by LSEL, 17 seat cushions (43 percent) had "box edged" welt, a style having welt cord around the top and bottom perimeters of cushions; 3 had "knife-edged" welt (8 percent), which is welt around the perimeter in the middle of the cushion; and 20 seat cushions were made without welt (50 percent). Since box-edged welt is around the top of the cushion, a cigarette is much more likely to come to rest against it than is the case with knife-edged welt, which is around the middle of the cushion. The 1995 survey of UFAC manufacturers found that an estimated 37 percent of seat cushions had box-edged welt.

ESTIMATED IGNITION PROPENSITY OF NEW FURNITURE PRODUCTION

Evaluation of the full scale chair test data shows that upholstery fabric fiber content is the major factor affecting ignition propensity of finished items of furniture. Of 12 (out of a total of 40) UFAC chairs that had one or more ignitions of test cigarettes, 10 were 100 percent cellulosic fabrics and 2 were predominantly cellulosic blended fabrics. No chair covered with predominantly thermoplastic fabric ignited.

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[5] Manufacturers were also asked to estimate the percentage of total yardage used that was *predominantly* thermoplastic (among other fiber types). Therefore, although not specifically defined in the questionnaire, it is likely that most respondents considered fabrics with blends of cellulosic and thermoplastic fibers to be predominantly cellulosic if their fiber content was more than 50 percent cellulosic, and predominantly thermoplastic if fiber content was more than 50 percent thermoplastic.

Ten of twelve chairs (83 percent) covered with 100 percent cellulosic fabrics had one or more ignitions, and two of eleven chairs (18 percent) covered with predominantly cellulosic blended fabrics had one or more ignitions. Previous studies have shown that, in general, the higher the thermoplastic fiber content in cellulosic-thermoplastic blended fabrics, the greater the resistance to cigarette ignition. Work done by the state of California found that as thermoplastic fiber content approaches 35 percent, the positive smolder-resistance properties of the thermoplastic fibers appear to override the negative smoldering qualities of the cellulosic fibers (and chairs or mockups would be more likely to resist ignition).[6]

The California work also showed that 100 percent cellulosic fabrics weighing more than 8 ounces per square yard are more likely to ignite from cigarettes than lighter cellulosic fabrics (such as most cotton print fabrics). The recent testing by LSEL also provides some evidence that ignition propensity of cellulosic fabrics generally increases with fabric weight. A larger percentage of test cigarettes tested on UFAC chairs covered with 100 percent cellulosic fabrics weighing more than 8 ounces per square yard resulted in ignitions than was the case with lighter 100 percent cellulosic fabrics. However, although this tendency was observed in these and previous test data, some heavy cellulosic fabrics resist ignition, and some lightweight cellulosic fabrics ignite readily when tested over similar filling materials. This points to factors in addition to weight, such as characteristics of the fabric weave, the presence of contaminants, fabric tension, and yarn size and density that also might affect the ignition propensity of fabrics. Since the effects of these other factors are not well-understood, estimates of ignitability based on fiber content and fabric weight involve some uncertainty.

Previous studies showed that welt edges of chairs covered with cellulosic fabrics could be more prone to ignition than other areas of a piece of furniture upon which a cigarette might come to rest. To address this, the industry developed welt cords that disperse heat, such as through the incorporation of aluminum foil. Analysis of the 40 UFAC chairs and 18 non-UFAC chairs that were tested by LSEL found that welt edges were not more likely to have ignitions from test cigarettes than seat cushions or side and back crevices. Of UFAC chairs with predominantly cellulosic fabrics, those with box welts were slightly more likely to have one or more ignitions of test cigarettes than

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[6] Damont, Gordon H. and Margaret A. Young, "Smoldering Characteristics of Fabrics Used as Upholstered Furniture Coverings," State of California Laboratory Report #SP-77-1, January 1977.

chairs without box welts. However, four chairs covered with heavyweight cellulosic fabrics, which accounted for a majority of test cigarette ignitions of UFAC furniture (for all test locations), also had box-edged welt. Non-UFAC chairs without box welts were more likely to have one or more ignitions than non-UFAC chairs with box welts (although there were only three non-UFAC chairs with box-edged welt). The chair test data show that the percentage of test cigarettes resulting in sustained ignitions at the welt edges was close to the percentages that ignited at other test locations. Therefore, with welt cords currently used by the furniture industry, the presence (or absence) of welt cord around the top of a seat cushion does not appear to be a major factor in determining the item's ignition propensity.

Based on these factors, it may be reasonable to evaluate the ignition propensity of new furniture by consideration of the ignitability of cellulosic fabrics, with the caution that factors besides fiber content and weight are not completely understood. UFAC chair test data for 100 percent cellulosic fabrics weighing less than 8 ounces per square yard show that 14 percent of the cigarettes tested at the back and side crevices, seat cushions, and welt edges led to ignitions. Cigarettes tested at these locations on UFAC chairs with heavier 100 percent cellulosic fabrics led to ignitions in 72 percent of the tests. As found in previous studies, fabrics that blend thermoplastic fibers (but still having more than 50 percent cellulosic fiber content) are less likely to ignite from the test cigarettes. None of the UFAC chairs covered with lightweight cellulosic blend fabric ignited. About 10 percent of the cigarettes tested on heavier cellulosic blend fabrics led to ignitions.

Looking at all UFAC test chairs with lightweight fabrics having 51 to 100 percent cellulosic fiber content, 9 percent of cigarettes placed on seat cushions, back (or back pillow) crevices, side crevices, and welt edges of chairs could be expected to lead to ignition. Also, 44 percent of such furniture items would be expected to have one or more ignitions. UFAC furniture covered with heavier predominantly cellulosic fabrics are estimated to have one or more ignitions on 57 percent of such items; with an estimated 39 percent of the cigarettes tested on seat cushions, back (or back pillow) crevices, side crevices, and welt edges leading to ignitions. Combining UFAC chairs with lightweight and heavier predominantly cellulosic fabrics, 52 percent had one or more ignitions, and 27 percent of the test cigarettes ignited.

Based on the survey of UFAC manufacturers, an estimated 17 percent of the fabric yardage used by those establishments were cotton print fabrics (lightweight cellulosic fabrics). Seventeen percent of fabrics yardage also was estimated to be

heavier predominantly cellulosic fabrics. Applying these estimated shares of total fabric yardage used to the estimated ignition propensities of furniture covered by such fabrics, about 16 to 17 percent of UFAC furniture would be expected to have one or more ignitions when three test cigarettes are placed on seat cushions, back (or back pillow) crevices, side crevices, and welt edges. Eight percent of the cigarettes placed on those locations would be expected to lead to sustained ignitions. Including test results of the 18 non-UFAC chairs would not change these estimated ignition propensities.

Although not found in the most recent testing program, earlier studies found that some furniture covered with predominantly thermoplastic fabrics could ignite from cigarettes, although ignition propensity was much smaller than for cellulosic fabrics. CPSC's 1984 testing of 40 UFAC chairs, for instance, found that 3 of 24 chairs covered with predominantly thermoplastic fabrics (12 percent) had sustained ignitions at one or more testing locations. Two percent of the cigarettes tested on these chairs led to ignitions. Also, although one non-UFAC chair tested was covered with silk fabric, none was among the 40 UFAC chairs. All three of the test cigarettes on the chair covered with silk fabric led to ignitions. Silk fabrics would be included in "other fiber types" in the survey data, and these combined for an estimated 2 percent of total fabric yardage used by UFAC establishments.

APPENDIX A.

UPHOLSTERED FURNITURE FLAMMABILITY TESTING: CIGARETTE IGNITION DATA ANALYSIS

United States
CONSUMER PRODUCT SAFETY COMMISSION
Washington, D.C. 20207

MEMORANDUM

DATE: July 22,1996

TO : Dale Ray, Directorate for Economic Analysis,
Project Manager, Upholstered Furniture

Through: Andrew G. Ulsamer, Associate Executive Director, AGU
Directorate for Laboratory Sciences

FROM : Linda Fansler, Textile Technologist,
Directorate for Laboratory Sciences

SUBJECT: Final Report: Upholstered Furniture Flammability
Testing: Cigarette Ignition Data Analysis

Attached is the final report from the cigarette ignition test program conducted at the Engineering Laboratory. The report presents and evaluates the results of the cigarette ignition testing on full scale chairs and the small scale cigarette ignition tests following the Upholstered Furniture Action Council's (UFAC) Program. Forty chairs manufactured by UFAC members and 18 chairs manufactured by non-UFAC furniture manufacturers were tested as part of this program.

Attachment

UPHOLSTERED FURNITURE FLAMMABILITY TESTING: CIGARETTE IGNITION DATA ANALYSIS

In 1993, the National Association of State Fire Marshals petitioned the Consumer Product Safety Commission (CPSC) to initiate a proceeding to regulate upholstered furniture flammability. On May 12, 1994, CPSC voted to defer a decision on that part of the petition dealing with cigarette ignition, pending an evaluation of the effectiveness of and the degree of industry conformance to the voluntary guidelines developed by the Upholstered Furniture Action Council (UFAC).

Commission staff developed a test program to determine the resistance of currently manufactured residential furniture to ignition from cigarettes. A total of fifty-eight chairs were purchased for this test program. Forty of these chairs were manufactured by UFAC members. The remaining 18 chairs were purchased from manufacturers not participating in the UFAC program. The chairs were tested as full scale furniture and then the components were tested according to the UFAC Voluntary Action Program. The attached CPSC staff report presents a description of this test program and an analysis of the test results.

UPHOLSTERED FURNITURE FLAMMABILITY TESTING: CIGARETTE IGNITION DATA ANALYSIS

July 17, 1996

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Directorate for Laboratory Sciences
Division of Engineering Laboratory

U.S. Consumer Product Safety Commission
Washington, D.C. 20207

The authors wish to acknowledge and thank the following test personnel:

Mechanical Engineer	John Murphy
Mechanical Engineer	Frank Vitaliti
Toxicologist	Lakshmi Mishra, PhD
Technician	Andrew Bernatz
Technician	William Keenan

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EXECUTIVE SUMMARY

In 1993, the National Association of State Fire Marshals petitioned the Consumer Product Safety Commission (CPSC) to initiate a proceeding to regulate upholstered furniture flammability. On May 12, 1994, CPSC voted to defer a decision on that part of the petition dealing with cigarette ignition, pending an evaluation of the effectiveness and degree of industry conformance to the existing Upholstered Furniture Action Council (UFAC) Voluntary Program.

The UFAC Voluntary Program was introduced in 1978 to improve the cigarette ignition resistance of upholstered furniture. The UFAC Program consists of component test methods and construction criteria for residential upholstered furniture.

In 1994, Commission staff developed a test program to determine the resistance of currently manufactured residential furniture to ignition from cigarettes. A total of 58 new chairs were purchased for this test program. Forty of these chairs were selected from a list of UFAC members and were expected to represent the performance of typical UFAC furniture. The remaining 18 chairs were purchased from manufacturers not participating in the UFAC Program.

The chairs were tested as full scale furniture following a CPSC Draft Proposed Standard for the Flammability (Cigarette Ignition Resistance) of Upholstered Furniture. The CPSC draft proposed standard includes an optional test of full scale furniture that evaluates the ignition potential of various locations on furniture from burning cigarettes.

Nineteen of the 58 full scale chairs tested did not resist ignition from cigarettes. Twelve of the 40 UFAC manufacturers' chairs ignited and seven of the 18 non-UFAC manufacturers' chairs ignited. An estimate of the proportion of current UFAC and non-UFAC production that would be expected to resist ignition will be developed after market distribution of furniture types data are applied to these results. Seventeen of the 19 chairs that ignited in the full scale tests were manufactured with component materials conforming to the UFAC Program.

To evaluate industry conformance, the chairs were also tested according to the existing UFAC Program. The UFAC Program is a series of component tests evaluating the ignition potential of individual components; these components are tested in combination with standard fabrics and/or filling materials.

Fifty of the 58 chairs tested met all of the required UFAC component tests. Thirty-seven of the 40 UFAC manufacturers' chairs met the requirements of the UFAC Program. Thirteen of the 18 non-UFAC manufacturers' chairs also met the requirements of the UFAC Program.

Cellulosic upholstery fabrics were more likely to ignite from cigarettes than chairs covered with thermoplastic fabrics or blends. None of the chairs covered with thermoplastic upholstery fabrics ignited.

INTRODUCTION

This report presents an analysis of test data and other information from cigarette chair tests conducted by the Directorate for Laboratory Sciences during fiscal years 1995 and 1996. These tests were performed in support of the Consumer Product Safety Commission (CPSC) project on upholstered furniture flammability. The purpose of this testing was to determine the extent to which currently produced residential furniture resists cigarette ignition.

BACKGROUND

In 1993 the National Association of State Fire Marshals (NASFM) petitioned the Consumer Product Safety Commission (CPSC) to develop a mandatory flammability standard for upholstered furniture under the authority of the Flammable Fabrics Act. Part of the petition requested that CPSC develop a standard to reduce risks from upholstered furniture fires ignited by cigarettes. On May 12, 1994, the Commission voted to defer a decision on that part of the petition dealing with cigarette ignition, pending an evaluation of the effectiveness and the degree of industry conformance to the existing voluntary program.[1]

The existing Voluntary Action Program was introduced in 1978 by the Upholstered Furniture Action Council (UFAC) to improve the cigarette ignition resistance of upholstered furniture. The UFAC Voluntary Program consists of component test methods and construction criteria.[2] Manufacturers that are UFAC participants, market furniture whose components meet the UFAC Program requirements; these firms are entitled to purchase UFAC hang tags to affix to their furniture.

In FY 1980, CPSC conducted tests on full scale new upholstered chairs to assess the resistance of UFAC labeled upholstered furniture to cigarette ignition. The results from the 1980 test program indicated that approximately 50% of the UFAC labeled furniture on the market at that time may ignite from cigarettes. In 1981 the Commission voted to defer consideration of a mandatory standard for the flammability of upholstered furniture until it was determined that there is a need for such consideration. The staff was directed to monitor the UFAC Program and to work jointly with UFAC to improve the ignition resistance of upholstered furniture through the industry's voluntary program. Full scale chair tests were repeated in 1983-1984, after UFAC implemented additional component requirements. The initial estimate of UFAC labeled furniture that may ignite from cigarettes based on the 1984 test program was 24%. This indicated a significant improvement in the resistance of

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[1]Superscript refers to references on page 23.

UFAC furniture to cigarette ignition.[3] A revised estimate was later made using updated survey information on upholstered furniture. After adjusting for a larger percentage of furniture containing welt cords, staff estimated that about 68% of the furniture would resist ignition by cigarettes.[4]

Since CPSC had not assessed the conformance with the UFAC Voluntary Program since 1984, the Commission decided to defer a decision on that portion of the NASFM petition requesting development of a mandatory standard to address cigarette ignition of upholstered furniture. The Commission instructed the staff to obtain additional information to evaluate the extent to which currently produced upholstered furniture (UFAC and non-UFAC) resists cigarette ignition and conforms to the UFAC Voluntary Program.

TEST PROGRAM

Objectives

The objectives of this test program were:

1. to evaluate the cigarette ignition resistance of current residential upholstered furniture in full scale tests, and

2. to evaluate the extent of furniture manufacturer's conformance with the UFAC Voluntary Program.

The CPSC Directorate for Engineering Sciences selected and purchased 58 pieces of upholstered furniture (56 chairs and 2 loveseats) used in this test program. In this report, all 58 pieces of furniture are referred to as chairs. Both UFAC and non-UFAC chairs were included with 40 chairs purchased from UFAC furniture manufacturers and 18 chairs from non-UFAC manufacturers. Two market studies[5,6] obtained from the furniture industry were used to select the chairs. An attempt was made to represent all major fabrics and popular furniture styles indicated in these studies.

Duplicates of 57 of the chairs were purchased, to insure sufficient materials for testing. The chairs were tested for cigarette ignition resistance, using the optional full scale test methods in the CPSC Draft Proposed Standard for the Flammability (Cigarette Ignition Resistance) of Upholstered Furniture.[7] Conformance with the UFAC Voluntary Program was also evaluated by testing the components used in the chairs according to the UFAC test methods, and by examining the construction of the chairs.

Test Methods

Full Scale Chair Tests

Commission staff initially tested all of the chairs to the full scale procedures specified in the CPSC Draft Proposed Standard for the Flammability (Cigarette Ignition Resistance) of Upholstered Furniture. The CPSC Draft Proposed Standard allows either a full scale test of the actual upholstered chair or a composite test of the actual fabric/filling combinations found in a piece of upholstered furniture. A series of cigarette tests are used to evaluate the ignition potential of locations on a chair where a cigarette may land and cause a smoldering ignition. Unfiltered Pall Mall cigarettes are used and each is covered by 5 inch squares of sheeting fabric. During the development of the standard, it was determined that various factors, such as different fabric/filling combinations contribute to different propensities for ignition. Locations that may have different fabric/filling combinations include the side/seat crevice, the back/seat crevice, the seat cushion surface, the front welt edge, the top of the arm, the top of the back and the decking.[3] These locations are shown in figure 1 below. In addition, definitions listed on pages 24 and 25 will assist in clarifying many of the terms used in this report.

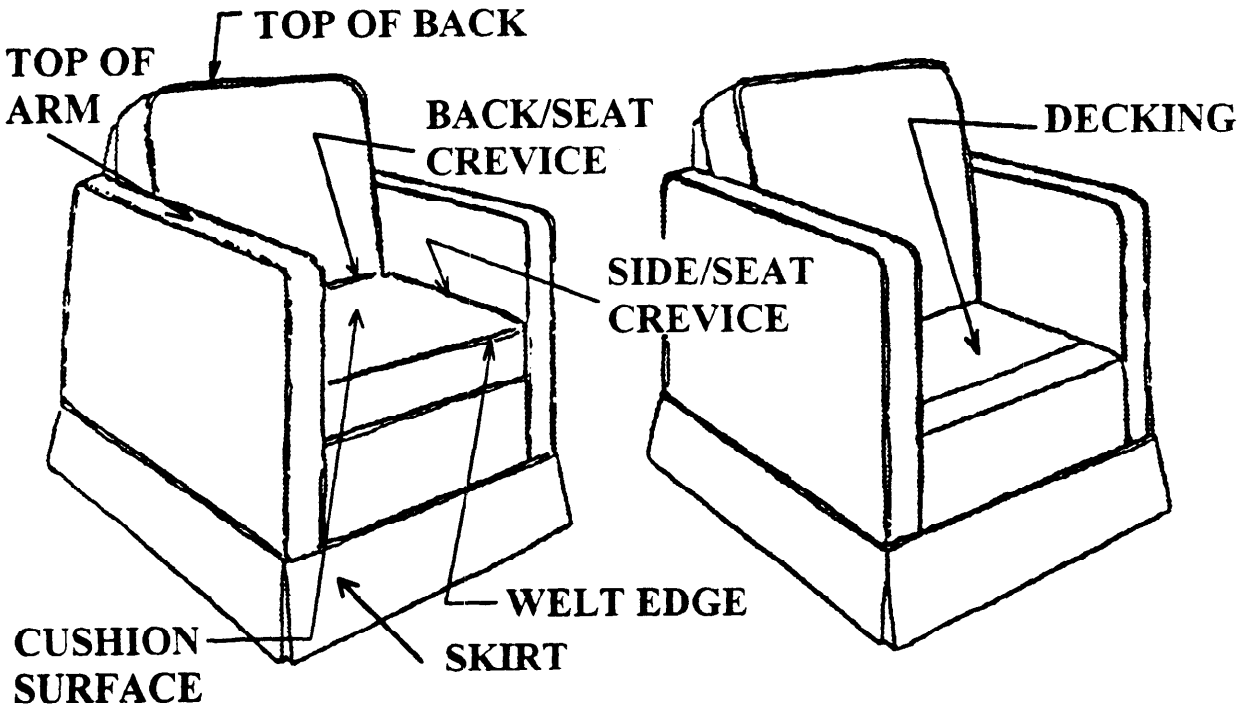

Figure 1 Typical Chair Locations

The full scale tests were conducted following the laboratory procedures used in the FY 1984 CPSC 40 Chair Test Program.[3] These procedures are the same as those listed in Part 1633.7 of the CPSC Draft Proposed Standard with the following modifications: three cigarettes (instead of two cigarettes) were placed on the welt edge and three cigarettes (instead of one cigarette) were placed on the seat cushion surface for cushions with welt cords in order to test each location equally with three cigarettes.

In order to conserve materials for further testing two other modifications to the Draft Proposed Standard were made. No cigarettes were placed on the top of the back, top of the armrest, or on the decking of the chairs. The draft standard specifies that three cigarettes be placed at each of these test locations. No retests of noncomplying surface locations, as allowed in Part 1633.6(e), were performed. The draft standard states that when only one cigarette out of the three tested at any location produces a failure, that test location may be retested with three additional cigarettes.

Three cigarettes were tested in each location of the chair including the seat crevices, front welt edges and seat cushion. Each cigarette was covered with the sheeting fabric during the test.

A test location is considered a failure if any one of the three cigarettes causes an obvious ignition or if the char from the cigarette extends more than three inches from the original location of the cigarette. The maximum char length was recorded for all cigarette test locations. The char length measurement was recorded to the nearest 0.1 inch. The maximum char length measurement was determined by measuring the length of the char on the vertical and horizontal test surfaces, and the char from the tip and butt ends of the test cigarette along the crevice locations of the chair. The char lengths were measured from the nearest point of the original location of the cigarette. When the original position of a cigarette was disturbed due to extensive fabric degradation an estimate of the maximum char length was made.

The design and construction of many of the chairs prohibited separating the cigarettes a minimum of 6 inches (3 inch char length allowance for each cigarette). Therefore, sometimes the 3 inch char from one cigarette overlapped into the char from an adjacent cigarette. When this condition occurred, ignition/non-ignition was determined by the char length measured in an area other than the overlap area. Even though the cigarettes were placed closer together than 6 inches, they still had two or three directions for the char to extend unobstructed.

During the full scale chair tests when smoldering from an obvious ignition (failure) progressed into the filling material instead of across the upholstery fabric, it was necessary in some instances to extinguish the ignition before the char on the

fabric had extended the required 3 inches. This reduced the potential danger to laboratory staff and conserved material for further testing.

Water was used to extinguish chair ignitions. The chair was allowed to become dry to the touch before beginning the 48 hour conditioning period to bring the sample back into condition for further testing.

When a pillow or bolster was part of the structural design of a chair, the crevice between the pillow and the seat or the bolster and the seat cushion was tested at the same time as the seat surface and welt edge. Then the pillow or bolsters were removed, and the back and side crevices of the chair were tested. When the test cigarettes were positioned in the back/seat crevice, they were allowed to drop down as far as they would naturally fall. This was also the case where there was a gap in the side/seat crevice of a chair when the side and seat met at a point below the top horizontal surface of the seat.

The welt edge in a box welt construction is a potential location where a cigarette may roll or land. The welt cord was tested as part of the full scale chair test only when it was located in a box welt construction on the seat cushion.

UFAC Classification and Component Tests

Following the full scale tests, each chair was disassembled and the components tested according to the UFAC Test Methods - 1990 (Decorative Trim Test Method - 1993).[2] The UFAC Voluntary Program consists of component test methods and construction criteria. In order for a UFAC member to use the UFAC hang tag, the firm must use upholstery fabrics that have been classified as Class I or Class II by the UFAC Fabric Classification Test Method. Each fabric is tested over a standard foam substrate. The resulting char length determines the fabric classification. Fabrics with a vertical char length of less than 1.75 inches above the mockup crevice are Class I. All other fabrics are Class II.

The firm must also use component materials that meet the test criteria of the following UFAC test methods:

1. The UFAC Filling/Padding Component Test, Part A - For Slab or Garnetted Materials;
2. The UFAC Filling/Padding Component Test, Part B - For Fibrous or Particulate Materials;
3. The UFAC Barrier Test;
4. The UFAC Welt Cord Test;
5. The UFAC Interior Fabric Test;
6. The UFAC Decking Materials Test; and
7. The UFAC Decorative Trims, Edging and Brush Fringes Test.

The UFAC test methods determine the cigarette ignition potential of components by evaluating them in combination with standard fabrics and/or filling materials, not the actual fabrics or filling materials to be used in the piece of furniture. The individual components are tested along with standard materials in a small scale mockup (figure 2). The mockup consists of two square pieces of wood, each nominally 8 inches by 8 inches and 0.75 inch thick, joined together at one edge. The pieces of wood support a vertical panel and a horizontal panel. Each panel consists of the component material being tested and the appropriate UFAC standard materials. Unfiltered Pall Mall cigarettes are used and are placed in the crevice formed at the intersection of the two panels. For the decking materials test, (figure 3) three cigarettes are placed on a flat panel mockup (13.5 inch by 21.0 inch). Each cigarette is covered with a 5 inch by 5 inch piece of unlaundered cotton sheeting fabric during the test. Three cigarettes are place on each component. If any one of the tests fail to meet the test criteria, then three retests are done. Two or more test failures constitute a failure of the component.

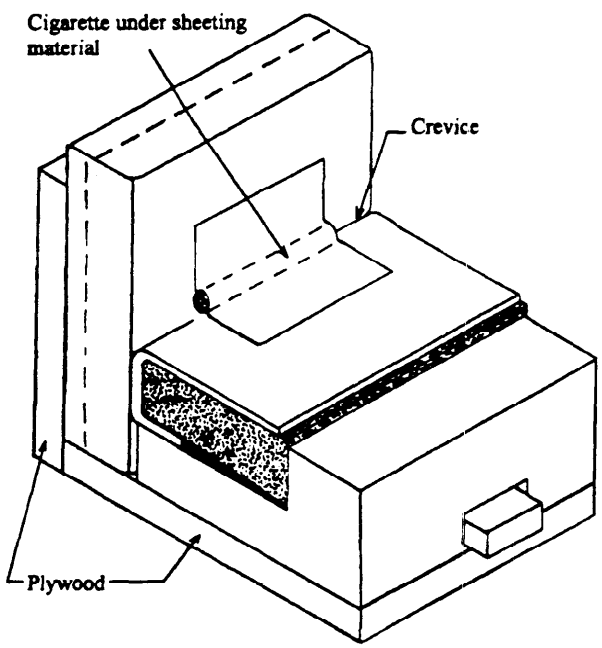

Figure 2 UFAC test mockup

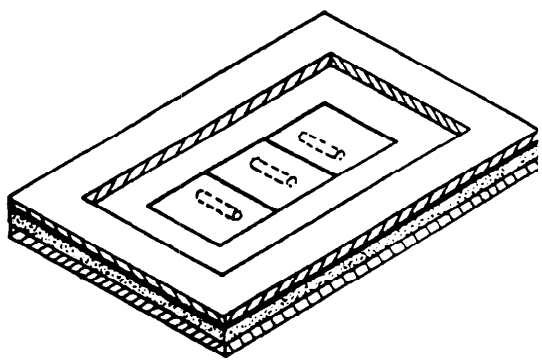

Figure 2 Decking Test

Test criteria includes an obvious ignition which is defined in the UFAC Program as "pronounced continuous and self-sustaining combustion of the test system",[2] and char length measurements measured on the vertical panel (decking is measured horizontally), upward from the cigarette. Char length measurements were determined by finding the maximum length over which the char completely degraded the cover fabric and then measuring to that point as discussed in the various test methods. Complete degradation was determined by inserting a pin through the char and moving the pin gently through the charred area until it stopped.

The UFAC component tests were conducted following the laboratory procedures used in the FY 1984 CPSC 40 Chair Test Program.[3] When dismantling the chairs, if the filling material used in two or more test areas (i.e., side, armrest, back) visually appeared to be the same, then only one UFAC Filling/Padding Component Test was performed. The test results were recorded as applying to both locations.

UFAC Filling/Padding Component Test

The UFAC Filling/Padding Test is designed to determine if filling/padding components exhibit sufficient resistance to smoldering cigarette ignition to meet the UFAC construction criteria.[2] Vertical and horizontal panels containing the filling/padding to be tested, are assembled, using the UFAC Standard Type I cotton mattress ticking as cover fabric. A lighted cigarette is placed in the crevice formed by the abutment of the vertical and horizontal panels in each test assembly, and is covered by the sheeting fabric. The cigarette is allowed to burn its full length. Char length is measured on the vertical panel, upward from the crevice and must be less than 1.5 inches to meet the UFAC criteria.

The UFAC Filling/Padding Test contains two parts; Part A covers foam and battings, and Part B covers loose fillings, (i.e. shredded foam, feathers, etc.). Loose filling materials often have an interliner fabric encasing the loose fill and are tested with the interliner fabric in addition to the UFAC Standard Type I mattress ticking cover fabric.

A UFAC Filling/Padding Component Test was performed on all filling/padding materials located directly beneath the upholstery fabric. Locations tested include seat, sides, armrest, back and pillow. When an insufficient amount of filling material was present to provide the required 2 inch thickness, composite specimens were prepared from both the first and second layers of filling materials located directly beneath the upholstery fabric. The UFAC Filling/Padding Test was performed on all foam seat cushions whether or not a barrier material was present.

UFAC Barrier Test

The UFAC Barrier Test is intended to define the minimum performance level for barrier materials to be used between Class II cover fabrics and conventional polyurethane foam in horizontal seating surfaces.[2] Vertical and horizontal panels are assembled using UFAC Standard polyurethane foam as the substrate and the Standard UFAC Type II rayon fabric as the cover fabric. The barrier to be tested is placed between the cover fabric and the foam substrate in both vertical and horizontal panels. A lighted cigarette is placed in the crevice formed by the abutment of vertical and horizontal panels and is covered by sheeting fabric. The cigarette is allowed to burn its full length. Char length is measured on the vertical panel, upward from the crevice and must be less than 1.5 inches to meet the UFAC criteria.

The UFAC Program requires the use of a barrier with Class II upholstery fabrics. A UFAC Barrier Test was performed on all barrier materials regardless if they were found under a UFAC Class I or Class II fabric.

UFAC Welt Cord Test

The UFAC Welt Cord Test is intended to identify welt cording that is suitable for use in seats, backs and pillows in UFAC approved constructions for reduction of the likelihood of cigarette ignition.[2] Welt cording is placed into the center of a piece of UFAC Standard Type II rayon fabric that is folded to make an unsewn welt. The unsewn welt is placed into the crevice formed by the abutment of vertical and horizontal panels that are assembled using UFAC Standard polyurethane foam as the substrate and Standard Type II rayon cover fabric. A lighted cigarette, covered by a piece of sheeting fabric is placed on the welt and against the vertical panel. The cigarette is allowed to burn its full length. Char length is measured on the vertical panel, upward from the crevice and must be less than 1.5 inches to meet the UFAC criteria.

UFAC Interior Fabrics Test

The UFAC Interior Fabrics Test is intended to establish an acceptable level of performance with cigarette ignition resistance for interior fabrics, those fabrics found directly under the upholstery fabric.[2] Vertical and horizontal panels are assembled using UFAC Standard Polyurethane Foam as the substrate. The vertical foam substrate is covered with the UFAC Standard Type I cotton mattress ticking fabric. The interior fabric to be tested is placed over the foam on the horizontal panel and is covered with the UFAC Standard Type I cotton mattress ticking fabric. A lighted cigarette is placed in the crevice formed by the abutment of vertical and horizontal

panels and covered by a piece of sheeting fabric. The cigarette is allowed to burn its full length. Char is measured on the vertical panel, upward from the crevice and must be less than 1.5 inches to meet the UFAC criteria.

UFAC Decking Materials Test

The UFAC Decking Materials Test is intended to determine the relative resistance to smoldering cigarettes of deck padding materials used under loose cushions.[2] The deck padding is the area under a cushion and functions as the support for loose seat cushions. The decking material is placed on the flat panel mockup and covered with the UFAC Standard Type II rayon cover fabric. A retaining ring holds the cover fabric in place during the test. Lighted cigarettes are placed on the mockup and covered with the sheeting fabric. The cigarettes are allowed to burn their full length. Char is measured and must be less than 1.5 inches to meet the UFAC criteria.

The UFAC Program tests deck padding materials used under loose seat cushions only. The UFAC Decking Materials Test was performed on deck padding materials found in both loose and tight seat constructions.

UFAC Decorative Trims, Edging and Brush Fringes Test

The UFAC Decorative Trim, Edging and Fringes Test is intended to classify decorative trim, edging and/or brush fringes that are used in furniture constructions where the decorative trim, edging or fringes are not covered with upholstery fabric.[2] The decorative trim, edging or fringe is placed at the abutment of the horizontal and vertical panels that are assembled using UFAC Standard foam as the substrate and the UFAC Standard Type II rayon cover fabric. A lighted cigarette, covered by the sheeting fabric is placed on the decorative trim and against the vertical panel. The cigarette is allowed to burn its entire length. Char length is measured on the vertical panel upward from the crevice and must be less than 1.5 inches to meet the UFAC criteria. If the decorative trim fails to meet the UFAC criteria, it is then tested using UFAC Standard Polyester Fiber Barrier material. A barrier material must be used in the furniture construction when a decorative trim is qualified for use with the UFAC Standard Barrier material.

Materials Identification

A qualitative analysis of fabrics, welt cords, filling materials and decorative trim used in each chair construction was performed. In all locations, except the seat cushion, the first type of filling material directly under the upholstery fabric was

analyzed as described below. When a composite specimen was tested, the first layer of filling material beneath the upholstery fabric and the second layer of filling material as found in the chair were analyzed. Analysis of the seat cushion included the interior fabric, barrier, foam and nonwovens.

Microscopic analysis and chemical solubility tests were used to identify the fiber contents of the upholstery fabrics, interior fabrics, filling materials, some of the welt cords and decorative trim.[8] The presence of backcoating on the upholstery fabric was determined by touch and visual observation as backcoating may affect the tendency of a fabric to smolder. Visual observations were used to describe some of the chair components such as feathers and some welt cords. A qualitative test method developed by BDH Chemicals Limited, using specified reagents, was used to determine the presence of borate in both battings and paper welt cords. Borate is often applied to cotton batting and paper to impart resistance to smoldering cigarette ignition.

Fabric weight was measured in oz/yd^2, and the foam and shredded foam densities were measured in lbs/ft^3. Batting, filling and fiberfill weights were measured in oz/ft^2. The thickness of filling materials was based on a single layer of filling. Actual thickness used in the chair and in testing may have been different. Welt cord diameters were measured in inches.

Infrared spectrophotometric analysis was used to identify the types of foam and plastic welt cords present in the chairs.

STANDARD MATERIALS USED IN THE TEST PROGRAM

All of the standard materials used in the chair test program were obtained from commercial sources and represent materials currently available to the furniture industry.

The CPSC Division of Hazard Analysis developed a sampling plan for verification testing of the standard materials to be used in the chair test program.[9] A sampling of the standard materials was checked to insure their conformance with the UFAC and CPSC (Draft Proposed Standard) specifications. The sheeting fabric (100% cotton), the UFAC Standard Type I Cover Fabric (100% cotton mattress ticking), and the UFAC Standard Type II Cover Fabric (100% woven rayon) were checked for fabric weight and fiber content. The polyurethane foam (polyether type) pieces were checked for density, foam type, and for conformance to the UFAC Filling/Padding Component Test. All the standard materials used in the test program met the respective specifications.

As specified in the CPSC Draft Proposed Standard, the cotton sheeting fabric (used to cover the lighted cigarettes) was laundered in an automatic home washing machine and dried in a tumble dryer once before use. The UFAC test methods do not specify laundered sheeting fabric. As in the 1984 Chair Test Program, unlaundered sheeting fabric was used for the UFAC tests.

CONDITIONING AND TESTING FACILITIES

UFAC and CPSC Conditioning Requirements

The CPSC Draft Proposed Standard requires conditioning of standard materials and test samples at a temperature greater than 18°C (65°F) and less than 55% relative humidity for at least 48 continuous hours prior to testing. The UFAC test methods require conditioning of standard materials and test specimens at a temperature of 21 ± 3°C (70 ± 5°F) and 50 to 60% relative humidity for at least 4 continuous hours prior to testing. All full scale chairs, upholstery fabrics, filling materials, standard materials and cigarettes were conditioned at the required specifications prior to testing.

Hygrothermograph recordings of the conditioning areas were made and charts were kept throughout the test program. If the conditioning area failed to maintain proper conditions, testing was suspended until conditions had been restored to the required specifications. If the test area failed to maintain specified conditions, then testing began within 10 minutes after the test item was removed from the conditioning area.

Conditioning Areas

The conditioning areas were two rooms, each equipped with their own heating and air conditioning system, openwork conditioning racks, and work benches. Humidifiers and dehumidifiers were operated as needed to maintain the specified relative humidity. In addition to these rooms, a Hot Pack environmental chamber, Model 883-14, was used to condition UFAC components before testing. The chamber was equipped with openwork conditioning racks. These areas housed the materials awaiting testing, including the full scale chairs, the UFAC mockup components, the standard materials, and the cigarettes. All standard materials and UFAC mockup components were cut to the required dimensions and placed on the openwork racks to facilitate air circulation for proper conditioning. Cigarettes were removed from their packages and placed in glass beakers during the conditioning period. Materials for the UFAC tests were conditioned for at least 4 hours prior to testing while all materials for the CPSC tests were conditioned for at least 48 hours.

Testing Areas

The full scale chair tests and the UFAC mockup tests were performed in two different testing locations. Both testing locations consisted of a draft-protected room with an exhaust fan, a vacuum cleaner, and an alcohol burner. The burn room for the full scale tests contained a breathing air system complete with positive pressure face masks and pressurized water sprayer (used to extinguish ignitions).

The air velocity of the full scale chair test room was measured with a hot wire anemometer. The air velocity was measured with the exhaust fan turned off and met the requirement of less then 200 ft/min given in the CPSC draft standard. The exhaust fan did not operate during testing, but was turned on at completion of the test to clear the room of smoke and fumes.

The UFAC component tests were performed in the draft-preventive enclosures specified in the UFAC test methods. Three draft-preventative enclosures were placed on a large table under a canopy hood. The draft-preventive enclosures met the UFAC air velocity requirement of a minimum 6 inch vertical smoke plume. The exhaust fan was operated on low speed during testing while smoke was being produced.

For both the full scale chair tests and the UFAC component tests, the cigarettes were lit using a vacuum cleaner to draw air through the cigarette as it was held over an alcohol burner. UFAC test ignitions were extinguished with water from a plastic squeeze bottle.

RECORDING OF DATA AND OBSERVATIONS

All data and observations for each full scale chair and UFAC component test were recorded on data sheets and filed according to chair number. Each chair was assigned a number, and a color photograph was taken of each chair prior to testing. All labels and tags removed from each chair as well as samples of each chair's components were cataloged according to chair number.

RESULTS

A number of tables (page 26) were prepared to describe the performance of the 58 chairs. The shaded areas in the tables indicate those chairs purchased from UFAC members, and the non-shaded areas those chairs purchased from non-UFAC furniture manufacturers.

Full scale test results for both UFAC and non-UFAC chairs are presented in Tables 1 and 2 followed by the results of the UFAC component tests (Tables 3 through 7) for both UFAC and non-UFAC manufactured chairs.

Full Scale Tests

The results of the chair tests are reported both in terms of the number of chairs that had one or more cigarette ignitions in any of the tested locations, and the number of cigarettes that resulted in ignition in all tests combined. The full scale results are also separated by UFAC and non-UFAC chairs.

Overall Chair Test Results

Table 1 shows the full scale test results for the 58 chairs by fabric type. Three lit cigarettes were placed in each test location on each chair as described in the section on Test Methods. The test location columns show the number of cigarettes that caused ignitions. The last two columns total the number of cigarettes that caused ignitions in each chair, and the number of cigarettes that were placed on each chair. As previously stated, a test location is considered a failure if any one of the three cigarettes causes an obvious ignition or if the char from the cigarette extends more than 3 inches from the original location of the cigarette. For purposes of this report, both ignition and a char length greater than 3 inches will be referred to as an ignition. Based on the CPSC Draft Proposed Standard's criterion of a complete chair resisting or not resisting ignition from a burning cigarette, a chair is considered to have ignited if one cigarette in one location ignites.

Overall 19 (32.8%) of the 58 chairs had at least one ignition, while 39 (67.2%) of the chairs resisted ignition from cigarettes. Twelve (30%) of the 40 UFAC manufactured chairs had at least one ignition. A somewhat higher percentage of the non-UFAC chairs ignited; seven of the 18 non-UFAC manufactured chairs (38.9%) had at least one ignition.

Ninety-nine (15.2%) of the 650 cigarettes placed on the chairs caused ignitions. 67 (14.7%) of the 455 cigarettes placed on the 40 UFAC chairs led to an ignition. 32 (16.4%) of the 195 cigarettes placed on the 18 non-UFAC chairs led to an ignition.

The test locations that were most likely to ignite from a cigarette included the seat crevices (back, side and pillow) as well as the seat cushion. This observation is in agreement with previous two test programs.

Fabric Type

The data for chair ignition by fabric type is also presented in Table 1. Eighteen chairs, (12 UFAC and six non-UFAC) were covered with cellulosic upholstery fabrics. Fourteen (77.8%) of these chairs ignited from at least one cigarette. Ten of these chairs that ignited were UFAC chairs and four were non-UFAC chairs. Eighty (39.2%) of the 204 cigarettes placed on chairs covered with cellulosic upholstery fabric resulted in an ignition.

Ten chairs (seven UFAC and three non-UFAC) were covered with thermoplastic upholstery fabrics. None of these chairs ignited from the 105 cigarettes placed on them.

Twenty-eight chairs (21 UFAC and seven non-UFAC) were covered with blend fabrics. Four (14.3%) of these chairs ignited. Two of these chairs were UFAC and two non-UFAC. Sixteen (4.9%) of the 329 cigarettes placed on chairs covered with blend upholstery fabrics led to an ignition.

No ignitions occurred on the leather chair while the chair covered with silk upholstery fabric ignited. Both of these chairs were non-UFAC. All three (100%) of the cigarettes placed on the chair covered with silk upholstery fabric led to an ignition.

The upholstered furniture in this study covered with thermoplastic fabrics resisted cigarette ignition substantially better, than furniture covered with cellulosic fabrics. The chairs covered with blend fabrics also resisted cigarette ignition more than those cellulosic fabrics. This was probably due to some of the blend fabrics containing a high enough percentage of thermoplastic fibers to resist cigarette ignition.[10]

Fabric Classification

A majority of the upholstery fabrics, 53 (91.4%), were determined to be UFAC Class I (Table 1). Only five (8.6%) of the fabrics were determined to be UFAC Class II. Four of these Class II fabrics were on UFAC chairs and one on a non-UFAC chair. The UFAC Program requires Class II upholstery fabrics to use a barrier between the fabric and the filling material in the seating area. As described below, all five chairs with Class II fabrics had barriers.

Thirteen (72.2%) of the 18 cellulosic fabrics were found to be Class I. Five (27.8%) of these 18 fabrics were UFAC Class II. All of the ten thermoplastic upholstery fabrics and all of the 28 blend fabrics were Class I. Both the one leather

and one silk fabric were Class I. The full scale test performance of the chairs shows that 14 (26.4%) of the 53 chairs covered with UFAC Class I fabrics had at least one ignition, while all five (100%) of the chairs covered with Class II fabrics ignited.

Fifty-eight (9.8%) of the 593 cigarettes placed on chairs covered with UFAC Class I fabrics led to an ignition, while 41 (71.9%) of the 57 cigarettes caused ignitions on chairs covered with Class II fabrics.

As expected, a higher percentage (100%) of the chairs covered with UFAC Class II fabrics (all cellulosics) ignited in the full scale tests than those covered with UFAC Class I fabrics (26.4%). Also a higher percentage (71.9%) of the cigarettes placed on chairs covered with Class II fabrics caused ignitions when compared to cigarettes placed on chairs covered with Class I fabrics (9.8%).

Fabric Construction

Of the 12 chairs covered with pile fabrics (velvet, corduroy, suede, or chenille), only one (8.3%) (a non-UFAC chair), ignited in the full scale test (Table 2). Three (33.3%) (two UFAC and one non-UFAC) of the nine chairs covered with jacquard fabrics ignited. For the plain fabrics, 11 (35.5%) (seven UFAC and four non-UFAC) of the 31 chairs ignited. Four (66.7%) (three UFAC and one non-UFAC) of the six chairs covered with print fabrics ignited.

Although approximately 67% of the chairs covered with print fabrics ignited, ignition may have been more a function of fiber content (all cellulosics), than fabric construction.

Backcoating

A visual examination of the fabric determined that nineteen chairs had backcoated upholstery fabrics (Table 2). The majority of the fabrics that were backcoated were either blends or thermoplastic upholstery fabrics; 70% of the thermoplastic fabrics and 83.3% of the blend fabrics were backcoated.

Overall, four (21.1%) of the backcoated fabrics ignited. Two cellulosic fabrics with backcoating ignited (one UFAC and one non-UFAC chair). Two blend fabrics with backcoating ignited (one UFAC and one non-UFAC chair).

Seat Style

In the analysis of the FY 1984 CPSC 40 Chair Test Program, seat style was discussed as a factor contributing to the ignition of upholstered furniture. Seat style was not considered a factor in this study as comparisons of box welt and weltless furniture could not be made. Identical upholstered chairs, (i.e., same fabric and filling), one with a box welt cushion and one without a box welt seat cushion are needed for a comparison of this type.

UFAC Component Results

The results of the UFAC component tests are discussed in terms of conformance with the UFAC Program for both chairs manufactured by UFAC members and non-UFAC furniture.

UFAC Conformance

The UFAC Program includes a series of materials tests with acceptance criteria. These tests are designed to prohibit the use of readily ignitable materials. Furniture made with materials that meet these requirements is eligible to display the UFAC hang tag. The hang tag is attached to furniture by the manufacturers and is not required by the UFAC Program. The hang tag also warns the consumer of the dangers of cigarette ignition. Twenty-seven (67.5%) of the 40 UFAC manufactured chairs arrived with a UFAC hang tag.

Construction Criteria Conformance

The UFAC construction criteria requires that furniture covered with a UFAC Class II upholstery fabric must be constructed with a barrier between the upholstery fabric and the foam used in the seat. All five of the chairs covered with a UFAC Class II upholstery fabric were constructed with a barrier containing thermoplastic fibers. Four of these chairs were manufactured by a UFAC member, and one chair by a non-UFAC furniture manufacturer. Forty-six (86.8%) of the chairs covered with Class I fabrics were also constructed with a barrier even though it is not required by UFAC.

UFAC Test Method Conformance

Table 3 shows the UFAC component test results for the 58 chairs. Each column shows the number of individual cigarettes that did not meet the test criteria in the specified UFAC test method. The seat cushion filling/padding test had the most failures, four (6.9%) of the 58 tests.

Overall, 50 of the 58 (86.2%)chairs passed all of the required UFAC component tests, including 13 non-UFAC chairs. Eight (13.8%) chairs failed to conform to at least one of the required UFAC tests, including three UFAC chairs.

For the 40 UFAC manufactured chairs, 37 (92.5%) met all of the required UFAC tests. Three of the UFAC chairs did not meet the UFAC Filling/Padding Test for the seat; one of these three chairs also failed to meet with the UFAC Barrier Test (which it was not required to have).

Of the 18 non-UFAC chairs, 13 (72.2%) passed all of the required UFAC tests. Three of the non-UFAC chairs failed the UFAC Barrier Test, and two chairs did not meet the UFAC Welt Cord Test. One non-UFAC chair failed the UFAC Filling Padding Test for both the back and seat filling materials.

Filling Materials and Other Components

Table 4 shows the UFAC Filling/Padding test results for the different types of filling materials used in the backs, sides, seat cushion and pillows of the chairs. The results of the UFAC welt cord test and a description of the welt cords tested can be found in Table 5. Table 6 shows the UFAC Decking Materials test results and types of decking materials found in the chairs tested. The results of the UFAC Interior Fabrics test and a description of the interior fabrics tested can be found in Table 7.

Back Filling

Predominantly thermoplastic materials (fiberfill, fillings, fiber pads) were used in the backs of the majority of the chairs. Other types of back filling materials included foam and cellulosic batting. One back filling material in a non-UFAC chair, ignited in the UFAC Filling/Padding test. This back filling material was a non-flame retarded treated cellulosic batting which is known to have little resistance to cigarette ignition. (The back filling was not tested in the full scale chair tests due to the style of this chair.)

Side Filling

The UFAC Filling/Padding test results (Table 4) for the different types of filling materials used in the side of the chairs show that predominately thermoplastic materials were used in the sides of most of the chairs. Other types of side filling materials included cellulosic and thermoplastic blend fillings and foam. There were no failures in the UFAC Filling/Padding test.

Seat Cushion Filling

As previously stated, 51 of the chairs contained a barrier between the upholstery fabric and the foam. Five chairs had foam directly beneath the upholstery fabric on the seat cushion. Two chairs contained feathers directly beneath the upholstery fabric and over the foam in the seat. The UFAC Barrier Test does not address loose fill type materials such as feathers, so the UFAC Filling/Padding Test, Part B - For Fibrous or Particulate Materials was performed for the feathers.

Four seat filling materials failed the UFAC Filling/Padding test. All four of the seat filling materials that ignited were foam (Table 4). Four of the 51 barriers tested did not meet the UFAC Barrier Test Method. Three of these barriers were thermoplastic fiberfill, and one was untreated cotton batting.

Pillow Filling

The types of filling materials and the test results for the loose back pillows found on 15 of the 58 chairs are shown in Table 4. Thermoplastic fiberfill was used in 13 of these pillows. Two contained feathers, one of these was a mixture of feathers and loose fiberfill. All pillow filling materials met the UFAC Filling/Padding Test criteria.

Welt Cords

Table 5 shows the test results for the different types of welt cords found in the chairs. Twisted paper with an aluminum core was the most prevalent welt cord in the chairs tested. Other types of welt cords included polyethylene with and without an aluminum core, twisted paper without an aluminum core, thermoplastic braid covering a thermoplastic core, thermoplastic nonwoven with and without an aluminum core and twisted paper covering a polyethylene core with a copper wire in the middle.

Two welt cords ignited in the UFAC Welt Cord test. Both of these welt cords were non-flame retarded twisted paper and were found on non-UFAC chairs.

Decking

Predominantly thermoplastic filling materials were used in the majority of the deckings of the chairs tested (Table 6). Most of the decking fabrics were woven blend fabrics. All of the decking materials met the UFAC Decking Materials Test.

Interior Fabrics

An interior fabric is a fabric found directly under the upholstery fabric. All of the interior fabrics met the UFAC Interior Fabric Test criteria (Table 7). The majority of the interior fabrics found in the chairs were nonwoven thermoplastics. Four chairs contained woven blend interior fabrics, while two chairs contained woven cellulosic interior fabrics.

Decorative Trim

Only two chairs contained decorative trim. The decorative trim was found on "throw" pillows that went with each of the chairs. One pillow was constructed with rayon/polyester fringe and the other pillow had cotton tassels. Both passed the UFAC Decorative Trims, Edging and Brush Fringes Test.

DISCUSSION

Full Scale Chairs

The majority of the chairs tested resisted ignition from burning cigarettes. Twenty-eight (70%) of the UFAC chairs did not ignite and 11 (61.1%) of the non-UFAC chairs did not ignite. The majority (72.7%) of the non-UFAC chairs that did not ignite were constructed with components that met the UFAC program. However, almost 90% of the chairs that ignited were constructed with component materials that conformed to the UFAC Voluntary Action Program. Thus, the use of components that pass the UFAC criteria did not ensure that the full scale upholstered chair would resist cigarette ignition.

The cellulosic content of the upholstery fabric is probably the most important factor in determining cigarette ignition. Seventy-seven percent of the chairs covered with cellulosic upholstery fabrics ignited. None of the chairs covered with thermoplastic upholstery fabrics ignited. In addition, non of the chairs covered with fabrics having blends of at least 50 percent thermoplastic fiber ignited.

In the previous FY 1984 CPSC 40 Chair Test Program,[3] 11 UFAC chairs (30%) ignited in the full scale chair test. In this study, 12 of the UFAC manufactured chairs (30%) ignited in the full scale test. The test data are however, unweighed so that; a direct comparison of these 12 ignitions with previous studies can not be made without considering the current market distribution of upholstery fabrics.

UFAC Conformance

The UFAC Voluntary Action Program is designed to prevent the use of furniture components that may lead to cigarette ignition of assembled furniture. The UFAC Program is not designed to predict the ignition performance of all UFAC furniture.

Thirty-three (66%) of the 50 chairs (25 UFAC and 8 non-UFAC) that conformed with the UFAC program also resisted cigarette ignition in the full scale tests. Seventeen (34%) of the 50 chairs (12 UFAC and 5 non-UFAC) that conformed to the UFAC Program ignited in the full scale tests.

Six (75%) of the eight chairs that did not conform with the UFAC program also resisted cigarette ignition in the full scale tests. Two (25%) of the eight chairs that conformed to the UFAC Program ignited in the full scale tests.

A substantial majority of the chairs included in this study were made of component materials that conform to the UFAC guidelines. About 93% of the 40 chairs manufactured by UFAC members met the required UFAC Test Methods. Seventy-two percent of the 18 chairs manufactured by non-UFAC furniture manufacturers conformed to the UFAC guidelines. Overall, 86% of the 58 chairs, both UFAC and non-UFAC conformed to the requirements of the UFAC Test Methods. In the previous 1984 study, only 20% of the UFAC chairs met the requirements of the UFAC Program. In addition, all of the chairs tested as part of the current study met the UFAC construction criteria by using a barrier with Class II upholstery fabric.

The majority of the chairs that ignited in the full scale tests were manufactured with materials that complied with the UFAC component tests. Of the 19 chairs with ignitions in the full scale tests, 17 (89.5%) chairs (12 UFAC and five non-UFAC) met all of the required UFAC tests. Two (10.5%) chairs, both non-UFAC chairs, were made with materials that failed to meet at least one of the UFAC tests.

Fabrics

The testing confirms that chairs covered with cellulosic upholstery fabrics are more likely to ignite from cigarettes than chairs covered with thermoplastic fabrics or blends. Most cellulosic upholstery fabrics used on the tested chairs were print or plain fabrics; fabric weight alone was not a deciding factor in determining ignition. Fabric weight in combination with some other factor(s) such as weave or filling material may influence ignition. The distinction in the UFAC guidelines between Class I and Class II fabrics had no bearing on ignition performance of these cellulosic fabrics.

Component Materials

Filling

Predominantly thermoplastic filling materials were the most commonly used filling materials in all locations. Generally these materials performed well; ignitions occurred in only six (three seat and three barrier) component tests. Only five of the polyether polyurethane foams used in the seat cushions of all 58 chairs did not meet the UFAC Filling/Padding Test.

Welt Cord

Twisted paper with an aluminum core was the most common type of welt cord in the chairs tested. This type of welt cord was involved in two chair ignitions. Thermoplastic nonwoven with aluminum core welt cords were involved in two other chair ignitions. The aluminized welt cord was developed in 1984 to directly address welt cord ignition and is considered to be highly effective in reducing cigarette ignition.[3] Therefore it is surprising that these ignitions occurred. The remaining welt cord ignition involved a thermoplastic braid surrounding a thermoplastic core.

Decking And Interior Fabrics

Thermoplastic fabrics or blend fabrics containing thermoplastic fibers were the predominate fabric type used as decking and interior fabrics. Thermoplastic filling materials were the predominate deck padding. In all cases the decking materials and interior fabrics met the UFAC test criteria.

Decorative Trim

Decorative trim was found on two chairs in this study. Although both trims contained cellulosic fibers, they met the UFAC test criteria.

SUMMARY

In summary, we cannot document any change in full scale furniture cigarette ignition resistance since 1984 until market proportions are applied to this data, although little change in the percent of conformance was indicated by the raw data. Similarly it appears that manufacturers' conformance with the UFAC component tests has improved substantially although market factors must be applied.

* Thirty-nine of the 58 full scale chairs resisted ignition from cigarettes.
* Twenty-eight of the 40 UFAC chairs did not ignite.
* Eleven of the 18 non-UFAC chairs did not ignite.
* Fifty of the 58 chairs tested met the required UFAC criteria.
* Thirty-seven of the 40 UFAC chairs met the required UFAC criteria.
* Thirteen of the 18 non-UFAC chairs met the required UFAC criteria.

There continues to be no direct comparison between the full scale and UFAC test results as the UFAC component tests were unable to consistently predict those chairs igniting in the full scale tests.

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DEFINITIONS

The following definitions will assist in clarifying many of the terms used in this report.

"Armrest" means the horizontal or near-horizontal surface that is the top surface of the side of an item of upholstered furniture and includes the components used to upholster this location.

"Back" means the rear wall of the seating cavity of an item of upholstered furniture and includes the components used to upholster this location.

"Barrier" means a protective layer of material between the upholstery fabric (or interior fabric, if present) and conventional polyurethane foam in the horizontal seating area to prevent contact between the upholstery fabric and foam.

"Batting" means a padding of cotton fibers processed in layers and lightly matted under pressure to permit ease of handling and control of the weight and the thickness of the padding.

"Bolster" means a loose or semi-attached cushion of upholstery fabric and perhaps interior fabric designed and constructed to be positioned in the seating cavity against the sides of an upholstered furniture item.

"Box Welt Construction" describes the design of a loose seat cushion with a welt cord edge around the perimeter of the top and bottom surface of the seat cushion.

"Decking" means the supporting medium for loose seat cushions.

"Decking Fabric" means the outermost layer of fabric or related material on the seat support system.

"Edge" means the seam or boundary edge of a seat, pillow, armrest, or back of an upholstered furniture item.

"Fabric Type" means an upholstery fabric of a specific construction, finish application, fiber content, nominal weight per unit area, color and print pattern.

"Fiberfill" means a padding of polyester fibers processed in layers and lightly matted under pressure to permit ease of handling and control of the weight and thickness of the padding.

"Filling" means a padding consisting of a mixture of fibers present in layers and lightly matted under pressure to permit ease of handling and control of the weight and thickness of the padding.

"Ignition" means the continued and increasing evolution of smoke from the cigarette test location after the cigarette has burned its entire length. Observations of continuous smoke and heat from the area of the cigarette test location at least 30 minutes after the cigarette has completed burning indicates that an ignition has occurred.

"Interior Fabric" is a fabric directly under the upholstery fabric used to cover and/or contain the filling material. Interior fabric is not found in all upholstered furniture pieces.

"Knife Edge Construction with Welt Cord" means a seam positioned in the middle of the thickness of a loose seat cushion or tight seat with a welt cord sewn in the seam.

"Pillow" means a loose or semi-attached cushion of upholstery filling covered with upholstery fabric (and perhaps interior fabric) designed and constructed to be positioned in the seating cavity against the back of an upholstered furniture item.

"Side" means the right or left wall of the seating cavity of an item of upholstered furniture and includes the components used to upholster this location.

"Specimen" means a piece of fabric, filling, or welt cord that is cut to specified dimensions for testing and is ready to be or has been mounted and assembled in a specified arrangement for testing.

"Standard Material" means any of the materials that are specified for use in the UFAC and CPSC test methods.

"Top of Back" means the horizontal or near-horizontal uppermost surface of the back of the main support frame of an item of upholstered furniture and includes the components used to upholster this location.

"Welt Cord Edge" means a seam or boundary edge which includes in its construction a welt cord sewn inside an upholstery fabric encasement.

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United States
CONSUMER PRODUCT SAFETY COMMISSION
Washington, D.C. 20207

MEMORANDUM

DATE: November 15, 1996

TO : Dale R. Ray, ECPA
Project Manager, Upholstered Furniture
Through : Warren J. Prunella, AED, EC
FROM : Charles L. Smith, EC (504-0962, ext 1325)
SUBJECT : Economic Considerations for Upholstered Furniture Petition FP 93-1

This memorandum discusses economic issues associated with Petition FP 93-1 to develop a mandatory standard addressing the cigarette ignition hazards of upholstered furniture.

I. Background

In 1993 the National Association of State Fire Marshals (NASFM) petitioned the Consumer Product Safety Commission (CPSC) to initiate a proceeding to regulate cigarette ignition hazards associated with upholstered furniture. NASFM sought the adoption of California's Bureau of Home Furnishings Technical Bulletins 116 and 117 as mandatory requirements for upholstered furniture sold for consumer use in the U.S. Technical Bulletin 116 calls for testing cigarette ignition resistance by placing cigarettes on specified locations of finished pieces of furniture (or mock-ups containing the fabric and filling material that is used). Conformance with Technical Bulletin 116 is voluntary in the state. Technical Bulletin 117 (mandatory for furniture sold in California) requires testing of the fabric and filling material components used to make furniture to assure their resistance to cigarette ignition.[1]

To evaluate the merits of the NASFM petition regarding cigarette ignition of upholstered furniture, Commission staff developed a test program to determine the

[1] Hazards associated with small open flame ignitions of furniture, addressed by some aspects of Technical Bulletin 117, are being considered separately by the staff; that part of the petition was granted by the Commission, and an Advanced Notice of Proposed Rulemaking was published on June 15, 1994, in the Federal Register.

resistance of new furniture to cigarette ignition, and the extent to which furniture conforms with the provisions of the voluntary program developed by the Upholstered Furniture Action Council (UFAC).[2] The Directorate for Laboratory Sciences has prepared a report on their findings from these tests.[3] The agency also contracted for a survey of upholstered furniture manufacturers in 1995 to acquire information on upholstery fabrics, filling materials, and other components of upholstered furniture that could affect the likelihood that an item of furniture might ignite from a burning cigarette. The Directorate for Economic Analysis reported on the survey findings.[4] A report was prepared on the likelihood that furniture would ignite from cigarettes, combining the findings of the test data and survey results.[5]

This memorandum presents information on the upholstered furniture industry, the hazards that would be addressed by a cigarette ignition standard, and the potential impacts of such a standard on furniture manufacturers and consumers.

II. Manufacturers and Production

Slightly more than 1,000 U.S. companies manufacture upholstered household furniture as their primary product (Standard Industrial Classification 2512). Several hundred companies that primarily manufacture other products, such as wood household furniture, also make upholstered furniture, although they only accounted for 3 percent of upholstered household furniture shipments in 1992. The market is fairly

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[2] The program requires classification of upholstery fabrics into either "Class I" or "Class II," based on a performance test. All conforming furniture must comply with specified construction criteria for welt cords, decking substrates, filling materials, and interior fabrics; and more cigarette ignition-prone Class II fabrics used with polyurethane foam seat cushions must have a barrier material between the fabric and foam that passes a barrier performance test.

[3] Gail Stafford and Linda Fansler, Directorate for Laboratory Sciences, Division of Engineering Laboratory, CPSC, "Upholstered Furniture Flammability Testing: Cigarette Ignition Data Analysis," July 17, 1996.

[4] Charles Smith, EC, CPSC, "Results of Surveys of Manufacturers of Upholstered Furniture," September 1996.

[5] Charles Smith, EC, and Linda Fansler, LSEL, CPSC, "Cigarette Ignition Propensity of Upholstered Furniture," October 1996.

concentrated among the larger firms. The top 4 companies accounted for 25 percent of the total value of upholstered furniture shipments in 1992, and the 50 largest companies accounted for 69 percent.[6] The industry includes many small establishments: the Bureau of the Census reports that, in 1992, more than half of all establishments manufacturing upholstered furniture as their primary product had fewer than 20 employees.

The value of domestic shipments of upholstered household furniture in 1993 was a little over $6 billion. The value of imports in that year was about $325 million, or about 5 percent of total shipments. The leading country of origin for imported furniture was Italy, accounting for 52 percent of upholstered furniture imports. The total annual retail value of upholstered furniture bought by consumers exceeds $12 billion. The number of upholstered furniture pieces purchased annually by households generally is in the range of 25 to 30 million units.

About 260 companies reportedly participate in the UFAC Voluntary Action Program.[7] Most of the larger producers of furniture are believed to be UFAC participants. According to estimates provided by officials of upholstered furniture manufacturers surveyed by Heiden Associates in 1994 (under contract to UFAC), 85 to 88 percent of the total value of shipments of wood frame upholstered furniture in 1993 complied with the UFAC program. Adding sleep furniture to upholstered wood furniture brought estimated compliance up to 86 to 89 percent of the dollar value of shipments of these two major categories of upholstered furniture.[8] Heiden Associates' information on the value of shipments of UFAC firms is consistent with Dun & Bradstreet data acquired by the CPSC contractor for the 1995 survey of manufacturers. Also, the recent testing of furniture components by the Directorate for Laboratory Sciences to determine conformance with UFAC tests does not contradict

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[6] Bureau of the Census, U.S. Department of Commerce, 1992 Census of Manufactures, report MC92-S-2, "Concentration Ratios in Manufacturing."

[7] The 260 companies now participating in the UFAC program are fewer than the 376 firms that reportedly were involved in the middle-1980's. However, this change is most likely related to consolidation of firms within the industry. Also, the earlier enrollment may have included branch locations in addition to company headquarters.

[8] Heiden Associates, Inc., "Report on Survey of UFAC Members re: Compliance with Upholstered Furniture Cigarette Ignition Flammability Standard," December 15, 1994.

the assertion that a high percentage of the total value of shipments of upholstered furniture conforms with the UFAC Program. An overall estimate of 90 percent conformance with the UFAC Program (if production by non-UFAC firms that technically is not certified is included) seems reasonable.

III. Potential Benefits of a Standard

In 1994 there were a total of 14,300 residential fires (from all ignition sources) involving upholstered furniture.[9] These fires resulted in an estimated 680 deaths, 1,780 injuries, and property losses of about $244 million. The estimated costs of upholstered furniture fires to society were nearly $4 billion. Fires started by cigarettes and other smoking materials accounted for 6,500 fires, 410 deaths, 960 injuries, and property losses of $107.8 million.[10] The societal costs associated with smoking material fires in which upholstered furniture was the first item ignited may have totaled about $2.3 billion in 1994, about 59 percent of all upholstered furniture fire hazard costs.[11] Based on Product Life Model estimates, there were nearly 400 million pieces of upholstered furniture in use in 1994. Annual hazard costs per unit averaged a little over $6. Based on an average product life of 14 years, and a discount rate of 5 percent, the discounted present value of hazard costs expected over the life of a piece of furniture averaged about $60 per unit in use in 1994.

Between 1980 and 1994, smoking material ignited fires involving upholstered furniture declined by 74 percent, deaths related to these fires declined by 64 percent, and injuries declined by 55 percent. The downward trend can be attributed to improvements in the general ignition resistance of furniture produced, as well as such other factors as increased presence of smoke detectors and sprinklers, and smaller proportions of the adult population that smoked cigarettes and drank alcohol. Because the number of fires declined more than deaths and injuries from 1980 to 1994, the

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[9] Kimberly Long, EHHA, CPSC, "National Fire Estimates for Smoking Material Ignited Upholstered Furniture Fires," October 1996 (Memorandum to Dale Ray, Project Manager, Upholstered Furniture).

[10] Property losses are 1994 dollars.

[11] Injury costs are based on "Societal Costs of Cigarette Fires," CPSC and National Public Services Research Institute, August 1993.

risks of death and injury per fire started by smoking materials increased. This indicates that the severity of the fires that do occur is increasing.

The results of chair testing and surveys of fabrics and filling materials used to make furniture in the 1980's and 1990's show that furniture produced in more recent years is generally much more resistant to ignition by cigarettes, the most frequent source of ignition. Because of the long product life of furniture, many upholstered furniture fires in 1994 likely involved older furniture that was more prone to ignition. Therefore, the expected hazard costs that a mandatory standard would address would be less than the average societal fire costs for furniture in use. Since current furniture production has a lower propensity to ignite than the average for all furniture in use, reductions in fires, deaths, and injuries from levels in 1994 can be expected to continue into the future, even in the absence of a standard, as new furniture replaces more ignition-prone furniture. Unless the ignition resistance of furniture produced in the future changes, fire losses (from replacement of more ignition-prone furniture) would be expected to stabilize at the level attributable to the ignition propensity of current production. Of course, factors other than furniture materials will also determine losses in the future. Some of these will tend to increase future losses (such as projected annual increases of about 1 percent in population and households) and others might decrease future losses (such as continued reductions in rates of smoking and alcohol consumption).

The major factor shown to affect the likelihood that an item of furniture will ignite from cigarettes are the percentage of cellulosic (*e.g.*, cotton and rayon) fiber content. In cigarette ignition tests by the CPSC's engineering laboratory this year, only chairs covered with fabrics that were made either entirely or predominantly from cellulosic fibers (with the exception of the one chair with silk fabric) ignited. Overall, about 27 percent of cigarettes tested on seat cushions, back (or back pillow) crevices, side crevices, and welt edges of UFAC chairs covered with predominantly cellulosic fabrics led to ignitions.[12] The 1995 survey of upholstered furniture manufacturers found that an estimated 31 percent of fabric yardage used was predominantly cellulosic. Most of the other fabrics used are much less prone to ignition from cigarettes: thermoplastic fabrics, leather and wool, and vinyl-coated fabrics. Based on historical data on the

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[12] Smith and Fansler, *Op. Cit.* This report also notes that cellulosic fabrics weighing more than 8 ounces per yard were more likely to be associated with sustained ignitions from test cigarettes than lighter cellulosic fabrics.

use of predominantly cellulosic fabrics, the Directorate for Economic Analysis estimates that such fabrics comprised about 39 percent of all fabrics in use in 1994.[13] Assuming the cigarette ignition hazard is proportional to the use of predominantly cellulosic fabrics, current ***production*** could be about 20 percent less likely to ignite from cigarettes than furniture ***in use*** in 1994. The surveys of manufacturers also indicated greater use of more cigarette ignition resistant filling materials, reduced presence of non-heat-conducting welt cord, and somewhat less use of heavier weight cellulosic fabrics. These other factors might contribute to an average ignition propensity associated with current furniture production that is up to 25 percent lower than for furniture in use in 1994. On this basis, if all furniture in U.S. households had fabrics and filling materials like those found in the 1995 survey of manufacturers, annual hazard costs would have been estimated to range from $1.7 to $1.8 billion instead of $2.3 billion. Based on the results of chair testing in recent years we may reasonably attribute perhaps 95 percent of expected cigarette ignition hazard costs to the estimated 31 percent of furniture covered with predominantly cellulosic fabrics.[14] On this basis, the average expected present value of cigarette ignition hazard costs for furniture covered by cellulosic fabrics would be about $140 per item and about $4 per item for furniture covered with other fabrics.

IV. Potential Impacts of a Standard on Furniture Manufacturers and Consumers

The CPSC solicited public comments on the petition in an August 8, 1993, Federal Register notice. The petitioner and parties that submitted comments provided little information with which to estimate the costs associated with the mandatory component and finished item (or mockup) tests sought by the petition. Based on information developed when the CPSC staff considered a draft mandatory standard in

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[13] Charles Smith, EC, CPSC, analysis in support of work done by the Technical Study Group, Cigarette Safety Act of 1984, published as part of a report by John R. Hall Jr., "Expected Changes in Fire Damages from Reducing Cigarette Ignition Propensity," October 1987.

[14] Although probably accounting for less than 2 percent of total fabric yardage used, chair testing indicates that silk fabrics might have no better resistance to cigarette ignition than cellulosic fabrics. Also, previous chair tests found that some chairs covered with predominantly thermoplastic fabrics resulted in sustained ignitions at one or more testing locations.

the 1970's, and on information about furniture intended for sale in California in recent years, relatively few modifications in furniture manufacturing materials may be necessary for most production to pass a mockup or finished item test similar to California's Technical Bulletin 116. This is because throughout the 1970's and into the 1990's the fabric and filling materials used to manufacture furniture generally shifted to those with greater resistance to ignition by cigarettes. The main effect of mandating requirements similar to Technical Bulletin 116 may be further shifts away from fabric types more prone to cigarette ignition, such as heavier cotton and rayon fabrics, towards more ignition resistant fabrics, such as those made with thermoplastic fibers. This would reduce consumer choice, and may have distributional effects within the textile industry.

Some furniture companies may incur additional manufacturing costs in order to retain fabrics in their product lines through the use of substrate materials that result in greater ignition resistance. In the project report to the Commission in 1987, the staff reported on industry efforts to develop foam cushioning materials with cigarette-ignition resistance superior to the flame-retardant foams complying with California's Technical Bulletin 117. Adoption of a mandatory standard requiring testing of finished items or mockups could accelerate efforts to develop such foams. Other means to continue to offer the same selection of fabrics and still pass a test might involve the use of interliners to improve ignition resistance. Interliners would entail costs for increased labor and material. Also, fabrics might be chemically treated with flame retardants to enable them to be used under the standard. Such treatments would increase costs of fabrics, and might affect the aesthetic characteristics. If prices of cellulosic fabrics increase relative to other fabrics and their desirable characteristics (such as appearance, "hand," and naturalness) are adversely affected by treatments, their purchases by consumers and use by furniture manufacturers would be expected to fall.

The 1995 survey of manufacturers also found that smaller manufacturers were more likely to use cellulosic fabrics. Therefore, a mandatory standard might also be expected to impose relatively higher increased costs for materials on smaller firms, unless they change their fabric selection.

A mandatory standard addressing cigarette ignition of finished chairs and the fabrics and materials used in their manufacture would likely have significant testing

and recordkeeping costs. Illustrative of this, the draft cigarette ignition standard considered by the CPSC staff in the 1970's included fabric classification testing, composite testing, and recordkeeping requirements. The estimated increase in manufacturing costs associated with compliance with these provisions was about $20 million in 1978. Adjusting these costs by the increase in the producer price index yields estimated costs of more than $30 million in current dollars. Markups of these costs might result in retail expenditures increasing over $75 million. The draft standard considered by the CPSC in the 1970's included a provision for fabric classification testing, which was intended to reduce the number of mockup tests required of furniture manufacturers. Although not a provision of Technical Bulletin 116, the inclusion of such a provision would mitigate testing cost impacts. Nevertheless, testing and recordkeeping costs would likely be disproportionately higher for smaller furniture manufacturers. Depending on how a standard accommodates furniture with fabric provided by the consumer ("Customer's Own Material" or "C.O.M." orders), firms for which such orders account for a significant percentage of their total production also might be disproportionately affected, since their average testing and recordkeeping costs per unit production would be higher.

V. Interdependency of Actions Addressing Cigarette and Open Flame Ignition Hazards on Prospective Benefits and Impacts on Industry

The benefits accruing from a standard addressing the cigarette ignition hazard are uncertain since changes in fabrics and other materials, such as greater use of thermoplastic fabrics, might increase the severity of fires that would still occur, including fires started by open flames. In fact, it is difficult to separate the benefits that might result from remedial measures aimed at cigarette ignition and the benefits from steps taken to reduce open flame ignitions. Since measures to reduce the latter hazard could also reduce the former, a combined approach may result in higher net benefits than addressing them one at a time. A combined approach might also be preferable from the standpoint of disruptions to the operations of furniture and upholstery fabric manufacturers. Perhaps even more important for upholstery fabric manufacturers, a combined approach provides forewarning that treatments may need to be developed addressing both cigarette and open flame ignition.